擠壓式壓電噴頭噴墨行為之數值研究

蔡煒銘、楊安石

E-mail: 9419552@mail.dyu.edu.tw

摘 要

噴墨現象受限於微米幾何尺寸的限制，經由實驗量測流場較 不容易，而建立一套噴墨列印設備需要耗費許多時間及反覆的測 試實驗。藉由模擬技術將可達到加速建立噴墨列印設備的時程與 建立相關製程技術之目的。本研究的首要目標在開發一可模擬壓 電式噴墨系統在列印過程中之液滴生成、飛行過程之三維電腦輔 助分析系統。 理論模型係基於三維暫態之質量與動量守恆方程式，採用連 續表面張力模式以模擬表面張力效應對液氣界面運動的影響，並 依據體體積法-分段連續界面重建（VOF-PLIC）之計算程序以描 述液體表面運動行為。預測結果與實驗量測比對可驗證理論模型 正確性，並加以延伸探討新型擠壓式噴頭之設計在改變模擬系統 製程參數 (包括噴液之表面張力、黏滯性與壓力波型態) 對液滴串 生成、斷裂與液滴飛行過程的影響。

關鍵詞 : 擠壓式壓電噴頭 ; 擠壓式壓電噴頭、噴墨列印過程、液滴行為、數值模擬、新型擠噴墨列印過程 ; 液滴行為 ; 新型擠壓式噴頭

目錄

參考文獻

1. Rayleigh, F. R. S.,“ On the instability of jets, ” in Proc. London Math.. Soc. Vol. 10 No. 4, 1878, pp.4-13. 2. Elmqvist, R.,“ Measuring instrument of the recording type, ” U. S. Patent 2566443, 1951 3. Sweet, R. G..,“ High frequency re- cording with electro-statically deflect ed ink-jets, ” Rev. Sci. Instrum. 36, 1965, pp. 131-136. 4. Buehner, W. L., Hill, J. D., Williams, T. H. and Woods, J. W.,“ Application of ink-jet technology to a word processing output printer, ” IBM J. Res. Dev. 21, Vol. 21 No.1, 1977, pp. 2-9. 5. Hertz, C. H. and Simonsson, S. I.,“ Ink-jet recorder, ” U. S. Patent 3416153, 1968 6. Heinzl, J.,“ Printing with ink droplets from a multi-nozzle device, ” in Adv. In Non-Impact Printing Technologies for Computer and Office Applications, Joseph Gaynor, Ed., 1981, pp.1191-1201. 7. Zoltan, S. L., (Clevite Corp.),“ Pulse droplet ejection system, ” U. S. Patent 3683212, 1974 8. Kyser, E. L. and Sears, S. B., (Silonic Inc.),“ Method and apparatus for recording with writing fluids and drop projection means therefore, ” U. S. Patent 3946398, 1976 9. Endo., Sato, Y., Saito, S., Nakagiri, T. and Ohno, S., (Canon),“ Liquid jet recording process and apparatus there for, ” Great Britain Patent 2007162, 1979 10. Vaught, J. L., Cloutier, F. L., Donald, D. K., Meyer, J.D., Tacklind, C.A. and Taub, H. H., (Hewlett-Packard),“ Ther-mal ink-jet printer, ” U. S. Patent 44907 28, 1984 11. Pimbley., W. T.,“ Drop Formation from a Liquid Jet: A Linear One-dimensional Analysis Considered as a Boundary Value Problem, ” IBM J. Res. Develop, Vol. 20, 1976, pp. 148- 156. 12. Curry, S. A. and Portig, H.,“ Scale Model of an Ink Jet, ” IBM J.Res. De velop, Vol. 21, No. 1, 1977, pp. 10-20. 13. Adams, R. L. and Roy, J.,“ A One-dimensional Numerical Model of a Drop-on- Demand Ink Jet, ” Journal of Applied Mechanics, Vol.53, No.1, 1986, pp. 193-197. 14. Asai, H., Toshitami, H., and Ichiro, E.,“ One-dimensional Model of Bubble Growth and Liquid Flow in Bubble Jet Printers, ” Journal of Japan Society of Applied Physics., Vol. 26, No.10, 1987, pp. 1794-1801. 15. Fromm, J. E.,“ Numerical Calculations of the Fluid Dynamics of Drop-on- Demand Jets, ” IBM J. Res. Develop, Vol. 28, No. 3, 1984,pp. 322- 333. 16. Shield, T. W., Bogy, D. B., and Talke,

P. E., " Drop formation by DoD Ink-jet Nozzles: A Comparison of Experiment and Numerical Simulation, " IBM J. Res. Develop, Vol. 31, No. 1, 1987 17. Asai, H., " Three-dimensional Calcu-lation of Bubble Growth and Drop Ejection in a Bubble Jet Printer, " ASME, Journal of Fluids Engineering, Vol. 114, No. 4, 1992, pp. 638 – 641. 18. Chen, P. H., Chen, W. C., and Chang, S. H., " Bubble Growth and Ink Ejection Process of a Thermal Ink Jet Printhead, " International Journal of Mechanical Sciences, Vol. 39, No. 6, 1997, pp. 683 – 695. 19. Chen, W. C., Chen, P. H., and Chang, S. H., " Development of Droplet String Injected by Thermal Bubble Printhead, " Proceeding of 14th Mechanical Engineering Conference, R.O.C., 1997, pp. 70 – 77. 20. Chen, P. H., Peng, H. Y., Liu, H. Y., Chang, S. L., Wu, T. I., and Cheng, C. H., " Pressure Response and Droplet Ejection of a Piezoelectric Inkjet Printhead, " International Journal of Mechanical Sciences, Vol. 41, No. 2, 1999, pp. 235 – 248 21. Liou, T. M., Chau, S. W., Chen, S. C., and Shih, K. C., " Numerical Investi-gation of Droplet Behavior in Inkjet Printing Process, " The 9th National Computational Fluid Dynamics Conference, Tai-Nan, Taiwan, August, 2002 22. Welch, J .E., Harlow, F.H., Shannon, J.P., Daly, B.J., " The MAC Method: A Computing Technique for Solving Viscous Incompressible, Transient Fluid Flow Problems Involving Free Surface, " Report LA-3425, Los Alamos Scientific Report, CA, USA. 23. Hirt, C. W. and Nichols, B. D., " Volume of fluid (VOF) method for the dynamics of free boundaries, " Journal Computational Physics,Vol. 39, No. 1, 1981, pp. 201-225. 24. DeBar, R., " Fundamentals of the KRAKEN Code, " Technical Report UCIR-760, LLNL, 1974. 25. Ashgriz, N., and Poo, J. Y., " FLAIR: Flux Line-segment Advection and Interface Reconstruction, " Journal of Computational Physics Vol. 93, No. 2, 1991, pp. 449-468. 26. Youngs, D. L., " Time-Dependent Multi-Material Flow with Large Fluid Distortion, " Morton, K.W., and Baines, M.J., editor, Numerical Methods for Fluid Dynamics 1982, pp. 273-285 27. Pilliod, J. E., and Puckett, E. G.. " Second Order Volume-of-Fluid Interface Tracking Algorithms. " Journal Computational Physics, Vol. 188, No. 1, 2003, pp.100-122 28. Noh, W. F., and Woodward, P. R., " SLIC (Simple Line Interface Method), " In A.I. Van de Vooren and Zandbergen, P. J., editors, Vol. 59, Springer-Verlag, 1976, pp. 330-340. 29. Beasley, J. D., " Model for Fluid Ejection and Refill of an Impulse Drive Jet, " J. Appl. Photogr. Eng., 3, 1977, pp.78-82. 30. Bugdayci, N., Bogy, D. B., and Talk, F. E., " Axisymmetric Motion of Radially Polarized Piezoelectric Cylinders used in Ink Jet Printing, " IBM J. Res. Develop., Vol. 27, No. 2, 1983, PP.171-180. 31. Bogy, D.B. and Talke, F. E., " Experimental and Theoretical Study of Wave Propagation Phenomena in Drop-on-Demand Inkjet Devices " , IBM Journal of Research and Development, Vol. 28, No.3, 1984, pp. 314-321. 32. Van Doormaal, J. P. and Raithby, G. D., " Enhancements of the SIMPLE Method for Predicting Incompressible Fluid Flows, " Numerical Heat Transfer, Vol. 7,1984, pp. 147-163. 33. Pilliod, J. E., and Puckett, E. G.. " Second Order Volume-of-Fluid Interface Tracking Algorithms. " Journal Computational Physics, Vol. 188, No. 1, 2003, pp.100-122. 34. Kothe, D. B., Rider, W. J., Mosso, S. J., Brock, J. S., Hochstein, J. I., " Volume Tracking of Interfaces Having Surface Tension in Two and Three Dimensions, " Technical Report AIAA 96-0859,[Presented at the 34th Aerospace Sciences Meeting and Exhibit, Reno, NV, Jan. 15-18, 1996 35. Meier, M., Yadigaroglu, G., and Smith, B. L., " A Novel Technique for Including Surface Tension in PLIC-VOF Methods, " European Journal of Mechanics B/ Fluids, Vol. 21, 2002, pp. 61-73. 36. Brackbill, J. U., Kothe, D. B., and Zemach, C. " A Continuum Method for Modeling Surface Tension, " Journal Computational Physics, Vol. 100, 1998, pp. 335-354. 37. Jang, D. S., Jetli, R., and Acharya, S., " Comparison of the PISO, SIMPLER, and SIMPLEC Algorithms for the Treatment of the Pressure-Velocity Coupling in Steady Flow Problems, " Numerical Heat Transfer, Vol. 10, 1986, pp. 209-228. 38. H.C. Wu, W.S. Hwang, H.J. Lin, " Development of a threedimensional simulation system for micro-inkjet and its experimental verification " , Materials Science and Engineering, A373, 268 – 278,2004